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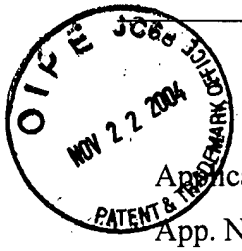

TRANSMITTAL

Applicant	:	Kato et al.
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For	:	FRAME ARRANGEMENT FOR OFF-ROAD VEHICLE
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Art Unit	:	3611

CERTIFICATE OF MAILING

I hereby certify that this correspondence and all marked attachments are being deposited with the United States Postal Service as first-class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on

November 17, 2004
(Date)

William H. Shreve, Reg. No. 35,678

Commissioner for Patents
P.O. Box 1450
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Sir:

Transmitted herewith for filing in the above-identified application are the following enclosures:

(X) English translation of U.S. Provisional Application 60/460,069, filed April 2, 2003 in 36 pages.

(X) Verification of Translation

(X) Return prepaid postcard.

(X) Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

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VERIFICATION OF TRANSLATION

I, undersigned below, hereby declare that:

My name and post office address are as stated below:

That I am knowledgeable in the English language and in the language in which the below identified U.S. Provisional Application was filed, and that I believe the attached English translation of the U.S. Provisional Application No. 60/460,069 filed on April 2, 2003 is a true and complete translation of the above-identified Provisional Application as filed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 10 / 8 / 2004

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[Document name] Specification

[Title of the Invention] BODY FRAME FOR ALL-TERRAIN VEHICLE

[Claims]

[Claim 1] A body frame for all-terrain vehicle having wheels for running over rugged terrain at respective right and left sides of front and rear portions of the vehicle and an engine mounted approximately at the center of the vehicle in fore and aft direction wherein at least part of the frame member enclosing the engine is mounted in the detachable manner.

[Claim 2] The body frame for the all-terrain vehicle according to Claim 1, wherein the frame member positioned above the engine and facing to a cylinder head is provided in the detachable manner.

[Claim 3] A body frame for an all-terrain vehicle having wheels for running over rugged terrain at respective right and left sides of front and rear portions of the vehicle and an engine mounted approximately at the center of the vehicle in fore and aft direction wherein the body frame is provided with: a center frame portion for mounting the engine and on which the riders put their feet; and front and rear suspension support frame portions for supporting front and rear suspension device to which front and rear wheels are swingably suspended in up and down direction and wherein the center frame portion is extended transversely relative to the front and rear suspension support frame portion and divided into front and rear frame members such that at least part of the front and rear frame members overlap in transverse direction when viewed from the side of the vehicle, and the abutting portion of both frame members are joined by welding.

[Claim 4] The body frame for all-terrain vehicle according to Claim 3, wherein the front frame member extends straight rearward to keep the same position as the front suspension support frame portion in transverse direction and is bent outward in the transverse direction at its rear end, the rear

frame member is formed by being bent outward in transverse direction from the rear suspension supporting frame portion, then being extended forward overlapping with the front frame member in the transverse direction, and being bent inward in the transverse direction at is front end, the front end bend portion of the rear frame member is welded to the outward side wall of the front frame member, and the rear end bend portion of the front frame member is welded to the inward side wall of said rear frame member.

[Claim 5] The body frame for all-terrain vehicle according to Claim 3 or 4, wherein the front and rear frame members have a rectangular cross section that a vertical side is longer than a horizontal side.

[Detailed Description of the Invention]

[Field of the Invention]

This invention relates to a body frame for an all-terrain vehicle.

[Description of the Prior Art]

Taking account of its operating conditions, this kind of all-terrain vehicle requires a body frame with additional strength and rigidity to deal with the shocks against the ground, as well as the improved supporting rigidity for an engine unit. To meet this requirement, some of the traditional all-terrain vehicles employ a structure in which the engine unit is mounted in the longitudinal center of body frame, with the engine unit generally enclosed in the frame members (See Patent Document 1). In addition, it would be possible in such body frame that the center frame portion is transversely stretched out relative to the front and rear suspension supporting frame portion in order to secure the mounting space of the engine unit, as well as the space of footrests for the riders. This structure will involve the left and right side members formed by bending them to swell outwardly at their center portion.

[Patent Document 1]

JP-Y-Hei 06-34213

[Problem to be Solved by the Invention]

However, difficulty lies in providing space required for the maintenance work when the structure enclosing the engine unit by the frame member like the conventional one is employed, causing the concern for poor serviceability, although engine supporting rigidity can be improved. In addition, employment of the structure to stretch out the center of body frame in the transverse direction involves the bending process of the side member into a convex shape. However, this bending process is hard to perform. Also, the rigidity against the bending moment can be deteriorated

depending on the performance conditions of the bending process. Additional cross member is needed to eliminate this issue, and increased number of components can be another issue.

This invention has been made to solve the conventional problem mentioned above. It is therefore an object of the invention to provide a body frame for an all-terrain vehicle that can assure the good serviceability while improving the engine supporting rigidity, and that can also secure the engine mounting space without the need for additional components such as cross members.

[Means for Solving the Problem]

The invention according to Claim 1 is characterized by having wheels for running over rugged terrain at respective right and left sides of front and rear portions of the vehicle and an engine mounted approximately at the center of the vehicle in fore and aft direction wherein at least part of the frame member enclosing the engine is mounted in the detachable manner.

The invention according to Claim 2 is characterized by, according to Claim 1, the frame member positioned above the engine and facing to the cylinder head is provided in the detachable manner.

The invention according to Claim 3 is characterized by a having wheels for running over rugged terrain at respective right and left sides of front and rear portions of the vehicle and an engine mounted approximately at the center of the vehicle in fore and aft direction wherein the body frame is provided with: a center frame portion for mounting the engine and on which the riders put their feet; and front and rear suspension support frame portions for supporting front and rear suspension device to which front and rear wheels are swingably suspended in up and down direction and wherein the center frame portion is extended transversely relative to the

front and rear suspension support frame portion and divided into front and rear frame members such that at least part of the front and rear frame members overlap in transverse direction when viewed from the side of the vehicle, and that the abutting portion of both frame members are joined by welding.

The invention according to Claim 4 is characterized by, according to Claim 3, the front frame member extends straight rearward to keep the same position as the front suspension support frame portion in transverse direction and is bent outward in the transverse direction at its rear end, the rear frame member is formed by being bent outward in transverse direction from the rear suspension supporting frame portion, then being extended forward overlapping with the front frame member in the transverse direction, and being bent inward in the transverse direction at is front end, and the front end bend portion of the rear frame member is welded to the outward side wall of the front frame member, and the read end bend portion of the front frame member is welded to the inward side wall of the rear frame member.

The invention according to Claim 5 is characterized by, according to Claim 3 or 4, the front and rear frame members have a rectangular cross section that a vertical side is longer than a horizontal side.

[Effects of the Invention]

According to the body frame of the invention in Claim 1, because at least part of the frame member enclosing the engine is mounted in the detachable manner, the space required to perform maintenance work on the engine is secured by removing the frame member, resulting in the improved serviceability while performing the engine maintenance. At the same time, the required engine supporting rigidity and the rigidity of vehicle body are assured by installing the frame member again after the maintenance work.

According to the invention according to Claim 2, because the frame member disposed above the engine cylinder head is detachably mounted, serviceability around the cylinder head requiring frequent maintenance is improved, and attaching and detaching work of the frame member becomes easier.

According to the body frame of the invention in Claim 3, because the center frame portion is transversely extended and divided into the front and rear frame members, with the front and rear frame members is disposed in the manner that at least part of them overlaps in transverse direction, and their abutting portion is joined by welding, it can be fabricated by simple process that is jointing the front and rear frame members by welding. Also, it provides additional rigidity to deal with the bending moment at the stretched-out part of the center frame portion, and further, it can prevent the increase in number of parts including cross members.

According to the invention in Claim 4, because the rear end portion of the front frame member is made to bend transversely outward, and the rear frame member is made to bend transversely outward from the suspension supporting frame portion, then to extend forward, and to bend transversely inward at its front end, the front end bend portion of the rear frame member is welded to the outward side wall of the front frame member, and the rear end bend portion of the front frame member is welded to the inward side wall of the rear frame member, the bending process is easier in comparison with the conventional process of bending the center portion of the side member into the convex shape, and at the same time improved frame rigidity against the bending moment can be obtained.

According to the invention in Claim 5, because the front and rear frame members are made of square pipe having rectangular cross section that the vertical side is longer than the horizontal side, the frame rigidity is further

improved.

[Embodiment of the Invention]

An embodiment of the present invention is described with reference to the attached figures.

FIGs. 1 to 13 illustrate a body frame for an all-terrain vehicle constructed in accordance with an embodiment of the present invention. FIGs. 1 and 2 are side view and top plan views of the all-terrain vehicle. FIG. 3 is a side view of an engine unit, FIG.4 is a schematic diagram o the engine unit viewed from the top. FIGs. 5 and 6 are schematic side and top plan views of a shifting mechanism of the engine unit. FIGs. 7 and 8 are perspective and top plan views of the body frame. FIG. 9 is a perspective view of the body frame. FIGs. 10 and 11 are side view and cross sectional front view of a front suspension device (sectional view at the line XI-XI in FIG. 10). FIGs. 12 and 13 are side view and cross sectional top plan view of a rear suspension device (sectional view at the line XIII-XIII in FIG. 12). Additionally, the terms "right," "left," "front" and "rear" mean right, left, front and rear sides which are defined when a rider is seated in the seat.

In the figures, the reference numeral 1 indicates an all-terrain vehicle. The vehicle 1 has front and rear wheels 3, 4 that mount low-pressure, large-width balloon tires on each right front, left front, right rear and left rear end of a body frame 2. The vehicle 1 has a seat 5 for two riders arranged at a generally center portion of the body frame 2 in a fore to aft direction. The seat 5 is divided into right and left pieces. The vehicle 1 also has an engine unit 6 below the seat 5.

The body frame 2 has a power transmission device 11 that distributes the power from the engine unit 6 to front and rear drive shafts 7, 8 and transmits the power to the front and rear wheels 3, 4 through front and rear differentials 9

and 10. The body frame 2 also has a steering device 13 that transmits a rotational movement of a steering wheel 12 which is disposed in front of the seat 5 to the front wheel 3. The body frame 2 further has front and rear suspension devices 14, 15 that suspend the respective right and left front and rear wheels 3, 4 such that those wheels 3, 4 can independently swing up and down. In addition, a hood 16 is arranged in a front area of the body frame 2 to have open and closed positions, and a carrier 17 is arranged in the rear of the seat 5.

The seat 5 is divided into right and left pieces 31, 30. The right and left pieces 31, 30 are detachably arranged and are transversely spaced apart from each other with certain gap between them. Each seat piece 31, 30 is provided with a seat cushion 31a, 30a and a seatback 31b, 30b that is united with the seat cushion 31a, 30a, respectively. The steering wheel 12 is positioned in front of the left seat piece 30.

The engine unit 6 is provided with a water-cooled, four stroke, single cylinder engine 35, and a transmission case 38 that is coupled to a front portion of the engine 35 and includes a crankcase 37a enclosing a crank shaft 37 transversely and horizontally extending, and a belt case 36a enclosing a V belt type continuously variable transmission 36. The engine 35 has a structure that includes the crankcase 37a that encloses a cylinder block 35b, a cylinder head 35c and a head cover 35d those of which are integrated and coupled to the crankcase 37a. A front wall 35e of the cylinder head 35c has an intake port 35f, and a rear wall 35g thereof has a pair of exhaust ports 35h.

The belt case 36a is connected to a left wall of the crankcase 37a, and encloses the V-belt type continuously variable transmission 36. The continuously variable transmission 36 is constructed to include a drive pulley 36d attached to the crankshaft 37, a driven pulley 36b attached

to an output shaft 39 that extends parallel to the crankshaft 37 and a V belt 36c wound around the drive pulley 36d and the driven pulley 36b.

The engine output from the output shaft 39 is transmitted to the front and rear drive shafts 7, 8 through a high, low and forward, reverse change mechanism 34 enclosed within the crankcase 37a, and a bevel gear mechanism 40.

A rear wall of the belt case 36a has an air inlet 36e through which air for cooling is introduced, and a front wall thereof has an air outlet 36f through which the air is discharged. A vertically extending cooling air intake duct 67 is connected to the cooling air inlet 36e. The cooling air intake duct 67 is located between the seat piece 31, 30 and in the rear of the seatback 30b, 31b. An upper end opening 67b of the cooling air intake duct 67 is located higher than the seat face of the seat cushion 30a, 31a, and opens toward the front part of the vehicle. A cooling air discharge duct 68 is connected to the cooling air discharge outlet 36f. The cooling air discharge duct 68, after being inclined upward, extends approximately horizontally from the raised position toward the rear part of the vehicle underneath the seat cushion 30a, with its rear end downstream opening 68b opening toward the rear part of the vehicle below the rear part of the seat cushion 30a.

The engine unit 6 is mounted onto the body frame 2 such that the output shaft 39 is positioned in front of the crankshaft 37, the crankshaft 37 and the output shaft 39 are placed below the seat 5, and a center line of the engine unit 6, running on a cylinder axis A, extends between the right and left seat pieces 31, 30 and is centrally positioned in the transverse direction relative to the vehicle body in the top plan view.

The major part of both the cylinder block 35b and the cylinder head 35c of the engine 35 is placed in the rear of

the respective rear ends of the seatbacks 31b, 30b of the right and left seats 31, 30 in the left side view of the vehicle. Also, the cylinder axis A slants upward to the rear part approximately 45 degrees relative to a horizontal line, for example.

An air intake device 45 extending forward relative to the vehicle body is connected to the front wall 35e of the cylinder head 35c, while an exhaust device 46 extending rearward relative to the vehicle body is connected to the rear wall 35g. The exhaust device 46 is provided with a pair of exhaust pipes 47, 47 which are coupled to the rear wall 35g to be connected to the respective exhaust ports 35h, and an exhaust muffler 48 which is coupled to each downstream end of the exhaust pipes 47. Each exhaust pipe 47 has a wavy shape that serpentines up and down in the side view. The muffler 48 is disposed and fastened around a rear end of the body frame 2 to transversely extend.

The intake device 45 is constructed such that a downstream end of the throttle body (carburetor) 50 is coupled to the front wall 35e through an intake pipe 49 to be connected to the intake port 35f, a down stream end of the intake duct 51 is coupled to a upstream end of the throttle body 50 through an accumulator 53, and an air cleaner 52 is coupled to a upstream end of the intake duct 51.

The throttle body 50 has a throttle valve 50a that opens and closes an intake passage. The accelerator 32 is joined to the throttle valve 50a through a throttle control cable (not shown). The air cleaner 52 is disposed behind and in the proximity of the hood 16 between the right and left front wheels 3.

A shift lever 42 is disposed at a front end of a space generally formed between the right and left seat pieces 31, 30. The shift lever 42 is used to change the shift positions among parking, forward H-N-L and reverse positions. The

shift lever 42 is positioned above and in the proximity of the transmission case 38 of the engine unit 6. The shift lever 42 and the foregoing change mechanism 34 are connected with each other through a linkage mechanism 41.

According to the illustrated embodiment, because the engine unit 6 is mounted such that the output shaft 39 and the crankshaft 37 are positioned below the seat 5, and that the output shaft 39 is positioned toward the front part of the vehicle relative to the crank shaft 37, the cylinder head 35c of the engine unit 6 is inevitably directed rearward. The engine unit 6 thus can be mounted onto the body frame 2 with a small rearward protrusion of the engine unit 6 without interfering the seat 5 or the feet of the riders. As a result, the wheelbase can be shortened, and thereby the vehicle body can be compact.

Also, because the cylinder head 35c is directed rearward, the engine heat is inhibited from affecting the riders. Hence, the riders can directly change seats between the right and left seat pieces 31, 30.

In the illustrated embodiment, a certain part of the cylinder block 35b and the cylinder head 35c of the engine 35 project rearward than the rear end of the seatback 30b, 31b, and the cylinder axis A inclines upward and rearward. Thus, the cylinder block 35b and the cylinder head 35c both having much heat can be spaced apart from the seat 5 or the riders, and thereby the influence by the engine heat can be avoided.

Also, because the intake device 45 is coupled to the front wall 35e of the cylinder head 35c positioned between the right and left seat pieces 31, 30, and the exhaust device 46 extending rearward is coupled to the rear wall 35g, effects of the engine heat on the engine intake system is prevented, and the stable engine output power is assured eventually. In addition, it allows the engine heat to escape to the rear of the vehicle, and allows to separate the

exhaust system from the fuel supply system. The adverse effect of the engine heat is thus prevented in this regard.

Next, the body frame 2 is described.

As shown in FIGs 1, 2, 7, 8, and 9, the body frame 2 according to the illustrated embodiment is provided with a main frame 20, a front frame 21, a rear frame 22 and a vehicle compartment frame 24. The main frame 20 is formed by right and left side members 18, 18 joined by transversely extending cross members 19, 19' and 19" at respective front, center, and rear portions of the side members 18, 18. The front frame 21 stands on a front portion of the main frame 20, and the rear frame 22 stands on a rear portion thereof. The vehicle compartment frame24 is disposed between the front frame 21 and the rear frame 22 of the main frame 20 to form a vehicle compartment together with the main frame 20.

The main frame 20 is located at the longitudinal center of the vehicle, and composed of center frame portion 20a suspending the engine unit 6, and front and rear suspension support frame portion 20b, 20c supporting the rear suspension device 14, 15 in combination with the front and rear frame 21, 22, with the center frame portion 20a being transversely extended relative to the front and rear suspension support frame portion 20b and 20c. Detailed structure is described in the following sections.

The right and left side members 18, 18 are divided into front and rear frame members 80, 81 which form a cross section having a rectangular shape that the vertical side is longer than the horizontal side. A straight front portion 80a of the front frame member 80 constitutes the front suspension support frame portion 20a. A rear end bend portion 80c is formed to bend outward in the transverse direction at the rear end of the center portion 80b constituting a part of the center frame portion 20a that is formed by being extended strait to the rear taking the identical transversal position

to the front portion 80a.

A straight rear portion 81a of the rear frame member 81 constitutes the rear suspension support frame portion 20c. A front end bend portion 81d is formed to bend inward in the transverse direction at the front end of the center portion 81c constituting a part of the center frame portion 20a that is formed by being bent transversely outward from the front end of the rear portion 81a and then further being extended straight forward. Here, the center portions 80b and 81c are overlapped in the transverse direction when viewed from the side of the vehicle.

Further, the front end bend portion 81d of the rear frame member 81 is joined by welding to the outward side wall of the front frame member 80 at approximately the boundary of its front portion 80a and the center portion 80b, while the rear end bend portion 80c of the front frame member 80 is joined by welding to the inward side wall of the rear frame member 81 at approximately the intermediate area of the center portion 81c.

Thus, the center portion 81c of the left and right rear frame member 81, 81, or the center frame portions 20a stretch out from the front portion 80a of the front frame member 80 and the rear portion 81a of the rear frame member 81, or front suspension support frame portion 20b and rear suspension support frame 20c. The engine unit 6 is mounted on each cross member 19' and 19" provided to bridge across the center portions 81c, 81c of the left and right rear frame members 81, 81. Also, the center portions 80b, 81c of the left and right front and rear frame members 80, 81 are transversely overlapped with certain distance between them, and the floor panel 23 is disposed to bridge the left and right center portions 80b, 81c each.

The rear frame 22 is constructed with left and right seat frame portions 22a on which the left and right seats 30,

31are mounted, and rear suspension frame portion 22b which constitutes the upper part of the rear suspension support frame portion 20c.

The seat frame portion 22a has horseshoe-shaped front and rear post members 82, 83 welded to the center portion 81c of the rear frame member 81, a square-piped upper frame member 84 welded to the top face of front and rear post members 82, 83 and extending rearward approximately in parallel with the rear frame member 81, a seat frame member 85 extending outwardly from the center portion 81c and then being inclined upwardly, and a seat cross member 86 made of sheet metal and welded to the seat frame member 85 and the upper frame member 84 for bridging them transversely.

A transversely extending engine frame member 87 is disposed is disposed to bridge the left and right seat cross members 86, 86. The engine frame member 87 has a structure that left and right L-shaped brackets 87a, 87a made of sheet metal are welded at the left and right end of the transversely extending square pipe 87b. Each bracket 87a is detachably tightened down to the seat cross member 86 by means of bolts 88, 88.

The engine 35 is framed in by; the front and rear post members 82, 83 and upper frame member 84 on its left and right sides, the cross member 19', 19' on its bottom face, and the engine frame member 87 on its top face.

The engine frame member 87 is disposed so that the square pipe 87b comes above the cylinder head 35c and the head cover 35d of the engine 35. Upper frame members 84, 84 are joined by the engine frame member 87 via the left and right seat cross member 86. In addition, working space for engine maintenance is created around the cylinder head 35c when the engine frame member 87 is removed by loosening each bolt 88.

Because the engine frame member 87 is detachably disposed above the engine 35, the body frame 2 according to the

illustrated embodiment allows securing the space required to perform maintenance work on the engine 35 by removing the engine frame member 87 after loosening each bolt 88. Serviceability is improved in this way. Also, as the maintenance work is completed, required rigidity for supporting the engine and the required frame rigidity are assured by re-tightening the engine frame member 87 with the bolt to make them fastened.

In addition, because the engine frame member 87 is detachably disposed above the cylinder head 35c and the head cover 35d of the engine 35, serviceability around the cylinder head 35c and the head cover 35d both requiring frequent maintenance is improved. Further, attaching and detaching work the engine frame member 87 is easy, because the operator is looking down on it in the course of operation.

Because the center portions 81c of the left and right side members 18 are stretched out from the front and rear portions 80a, 81a and are divided into the front and rear frame members 80, 81, and the center portions 80b and 81c of the front and rear frame members 80, 81 are disposed transversely overlapped with certain distance between them, the body frame 2 according to this illustrated embodiment is fabricated by simple process that is jointing the front and rear frame members 80, 81 by welding. Also, it provides additional rigidity to deal with the bending moment at the stretching-out portion of each side member 18, and further, it can prevent the increase in number of parts when compared with the traditional method to add a cross member.

Because the rear end bend portion 80c of the front frame member 80 is made to bend transversely outward, the rear frame member 81 is made to bend transversely outward from the rear portion 81a, then to extend forward, and to bend transversely inward at its front end bend portion 81d, the

front end bend portion 81d is welded to the outward side wall of the front frame member 80, and the rear end bend portion 80C being welded to the inward side wall of the rear frame member 81, bending process is easier than the conventional process in which single side member is bent into a convex shape at its center portion, and at the same time, the frame rigidity against the bending moment is improved.

Also, because the front and rear frame members 80, 81 are made of square pipe having a rectangular cross section that the vertical side is longer than the horizontal side, the frame rigidity is improved further.

Next, the rear suspension device 15 is described.

The rear suspension device 15 of the illustrated embodiment is of a double-wishbone type in which the rear suspension device is disposed at the left and right on the rear part of the body frame 2, and provided with upper and lower rear suspension arms 90, 91 to support the respective right and left rear wheels 4, 4 such that those wheels 4, 4 can independently swing up and down. The upper and lower rear suspension arms 90, 91 are connected with each other at their external ends by a link member 92, with the rear wheel 4 being rotatablly supported with a shaft by the link member 92. In addition, a damper (not shown) is disposed between the upper rear suspension arm90 and the upper frame member 84.

The upper frame member 84, located above the rear suspension support frame portion20c to support the rear suspension device 15 in combination with the rear suspension support frame portion 20c, extends approximately in parallel with the rear frame member 81. However, the rear portion 84a of the upper frame member 84 runs in the deflective manner so that it is located transversely outer than the rear portion 81a of the rear frame member 81.

The rear portions 84a, 81a of the upper frame member 84 and rear frame member 81 are respectively connected by

welding via vertically extending front and rear vertical frame members 94, 95. The front and rear vertical frame members 94, 95, having approximately horseshoe-shape that opens to the exterior of the vehicle, are composed of pairs of side walls 94a, 94a and 95a, 95a respectively located forward and rearward in cross-sectional view and integrally connected by bottom walls 94b, 95b.

Here, the front and rear vertical frame members 94, 95 are spaced apart by certain distance in longitudinal direction, and are positioned slantingly so that the upper they go, the more outward they stretch. Thus, the arm length of the upper rear suspension arm 90 is shorter than the arm length of the lower rear suspension arm 91, enabling the rear wheel 4 to swing up and down in generally perpendicular direction.

Upper and lower mount members (axially supporting portion) 90a, 91a are fixed firmly at the front and rear anchoring ends of the upper and lower rear suspension arms 90, 91, with their axial lines oriented in longitudinal direction. These four mounting members 90a, 91a are located within the horseshoe shape of the front and rear vertical frame members 94, 95, and are axially supported in the rotatable manner by means of a support pin 96 inserted penetrating the front and rear side walls 94a, 95a.

According to the rear suspension device 15 in the illustrated embodiment, because the rear portions 84a, 81a of the upper frame member 84 and rear frame member 81 are respectively connected by vertically extending front and rear vertical frame members 94, 95, and because each mount member 90a, 91a of the upper and lower rear suspension arms90, 91 are axially supported by the front and rear vertical frame members 94, 95, the mounting position of the upper and lower rear suspension arms 90, 91 can be adjusted vertically in more flexible manner without changing the basic structure of

the body frame 2.

In addition, because the front and rear vertical frame members 94, 95 have horseshoe-shaped cross section, and each mounting member 90a, 91a of the upper and lower rear suspension arms 90, 91 is axially supported directly by utilizing the horseshoe-shape, conventional brackets are eliminated, and there is no need to control the welding strength, which gives advantage in terms of the strength and the manufacturing cost.

According to the illustrated embodiment, because in the front and rear vertical frame members 94, 95 are disposed slantingly so that the upper part is positioned more outward of the vehicle to make the arm length of the upper rear suspension arm 90 shorter than the arm length of the lower rear suspension arm 91, rolling ability at the turning of the vehicle is improved.

Because the front and rear vertical frame members 94, 95 have horseshoe-shape that opens to the exterior of the vehicle, with each mount member 90a, 91a of the upper and lower rear suspension arm 90, 91 being located within the horseshoe-shape of the front and rear vertical frame members 94, 95 and being axially supported by a support pin 96, the improved flexibility is attained regarding the vertical mounting position of the upper and lower rear suspension arms 90, 91.

Also, because every mounting member 90a, 91a of the upper and lower rear suspension arms 90, 91 are axially supported by the front and rear vertical frame members 94, 95, the flexibility is further improved regarding the mounting position of the rear suspension device.

Next, the front suspension device 14 is described.

The front suspension device 14 of the illustrated embodiment has a structure that upper and lower front suspension arms 100, 101 disposed at the left and right on

the front part of the body frame 2 support the respective right and left front wheels 3, 3 such that those wheels 3, 3 can independently swing up and down, and that a damper (not shown) is disposed between the upper front suspension arm 100 and the body frame 2. The upper and lower front suspension arms 100, 101 are connected with each other at their external end portions by a link member 102, and the link member 102 rotatably supports a shaft of the font wheel 3.

Front and rear suspension frame members 103, 104 spaced apart by certain distance in longitudinal direction constituting a part of the front frame 21, are welded to the front portion 80a of the left and right front frame member (lower frame) 80 on the body frame 2. The front suspension frame member 103 first extends vertically upward from the front end of the front frame member 80, and then extends slantingly upward toward the rear part of the vehicle. The rear suspension frame member 104 extends in parallel with the front suspension frame member 103, with its upper end being welded to the front suspension frame member 103. Also, the front and rear suspension frame members 103, 104 are connected via a longitudinally extending reinforcement 105, and the left the right rear suspension frames 104, 104 are connected via a transversely extending reinforcement 106 respectively. The front part 80a of the front frame member 80 has longer-than-wide rectangular cross section, with outward-facing vertical wall 80d of the rectangular shape being a flat surface. Outward-facing vertical walls 103a, 104a of the front and rear suspension frames103, 104, are flat surfaces as well.

Lower brackets 107, 108, having horseshoe-shaped cross section and being spaced apart by certain distance in longitudinal direction, are welded to the outward-facing vertical wall 80d of the front frame member 80. The front lower bracket 107 is oriented to make its horseshoe-shape

opening face upward, while the rear lower bracket 108 is oriented to make its horseshoe-shape opening facing downward.

Upper brackets 109, 110 having horseshoe shape are welded to the outward-facing vertical walls 103a, 104a of the front and rear suspension frame members 103, 104. The front upper bracket 109 is oriented to make its horseshoe-shape opening face outward, while the rear upper bracket 110 is oriented to make its horseshoe-shape opening facing outward and at the same time positioned lower than the front upper bracket 109. In addition, the distance between each upper bracket 109, 110 is set to be smaller than the distance between each lower bracket 107, 108.

Upper and lower mount members (axially supporting portion) 100a, 101a, slanted a little to raise their front part relative to the rear part, with their axial lines oriented in longitudinal direction, are fixed firmly at the front and rear anchoring ends of the upper and lower front suspension arms 100, 101.

Each upper mounting member 100a is supported in the rotatable manner by means of an upper support pin 111 inserted penetrating each upper bracket 109, 110. In addition, each lower mounting member 101a is supported in the rotatable manner by means of a lower support pin 112 inserted penetrating each lower bracket 107, 108. The lower mounting member 101a at the rear is positioned lower than the lower mounting member 101a at the front. The axial line connecting each lower mounting member 101a runs in parallel with the axial line connecting each upper mounting member 100a, and at the same time it slants upward a little toward the front.

According to the front suspension device 14 in the illustrated embodiment, because the outward facing vertical wall 80d of the front frame member 80, as well as the outward-facing vertical walls 103a, 104a of the front and rear suspension frame member 103,104 are made to be the flat

surfaces, and the upper and lower brackets 107 through 110, supporting the upper and lower front suspension arms 100, 101 are firmly welded on each of the outward-facing vertical wall 80d, 103a, 104a, the mounting position of each bracket 107 through 110 can be selected freely, resulting in the improved flexibility regarding the swing angle of the front suspension without the need for changing the basic structure of the body frame.

In addition, according to the illustrated embodiment, because each rear mounting member 100a, 101a for the upper and lower front suspension arms 100, 101 is positioned lower than each front mounting member 100a, 101a, improved stability of the vehicle attitude is obtained when it steps on the obstacles like large rocks.

Further, because the front frame member 80 is made to have a rectangular cross section that the vertical section is longer than the horizontal section, and the front suspension arm 101 is supported by the rectangular-shaped outward facing vertical wall 80d, the front frame member 80 is made in such simple shape, resulting in the improved frame rigidity.

[Brief Description of Drawings]

Fig. 1 is a side view of an all-terrain vehicle to explain an embodiment of the present invention.

Fig. 2 is a top plan view of the all-terrain vehicle.

Fig. 3 is a side view of an engine unit of the all-terrain vehicle.

Fig. 4 is a schematic diagram of the engine unit viewed from the top.

Fig. 5 is a schematic side view of a shifting mechanism on the engine unit.

Fig. 6 is a top plan view of the shifting mechanism.

Fig. 7 is a perspective view of the body frame for the all-terrain vehicle.

Fig. 8 is a top plan view of the body frame.

Fig. 9 is a perspective view of the body frame.

Fig. 10 is a side elevation view of a front suspension device of the all-terrain vehicle.

Fig. 11 is a sectional front elevation view of the front suspension device (sectional view at the line XI-XI in Fig. 10).

Fig. 12 is a side elevation view of a rear suspension device of the all-terrain vehicle.

Fig. 13 is a sectional top plan view of the rear suspension device (sectional view at the line XIII-XIII in Fig. 12).

[Description of Reference Numerals]

1: all-terrain vehicle
2: body frame
20a: center frame portion
20b: front suspension support frame portion
20c: rear suspension support frame portion
3: front wheel
4: rear wheel
6: engine unit
14: front suspension device
15: rear suspension device
35: engine
35c: cylinder head
80: front frame member
81: rear frame member
87: engine frame member

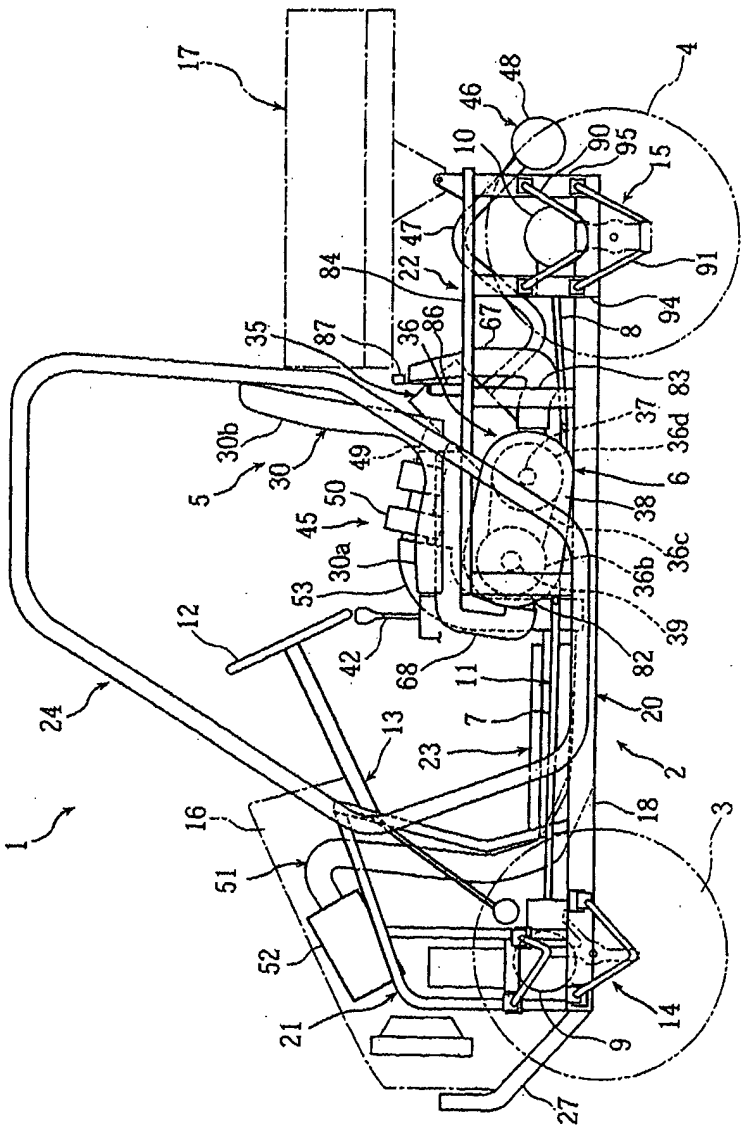

FIG. 1

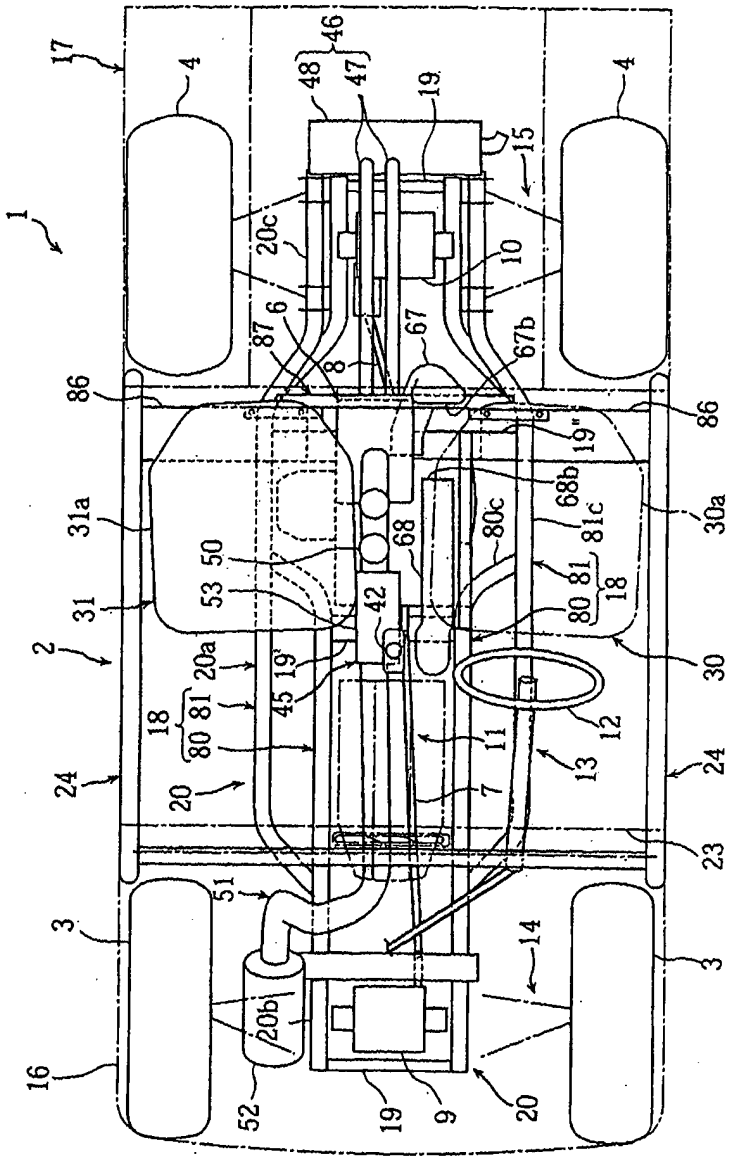

FIG. 2

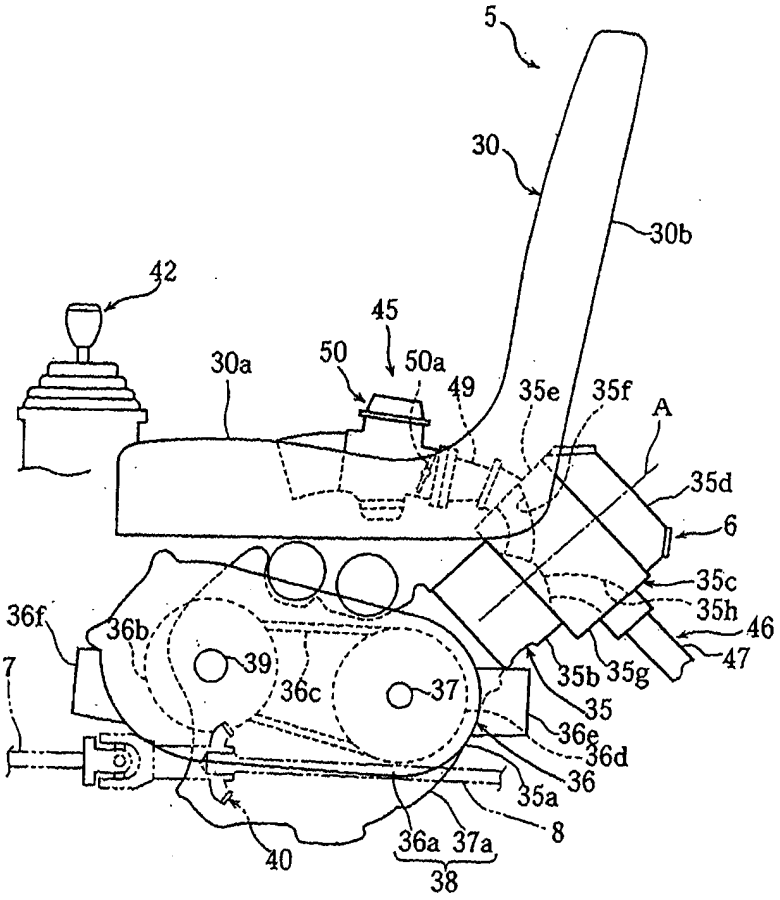

FIG. 3

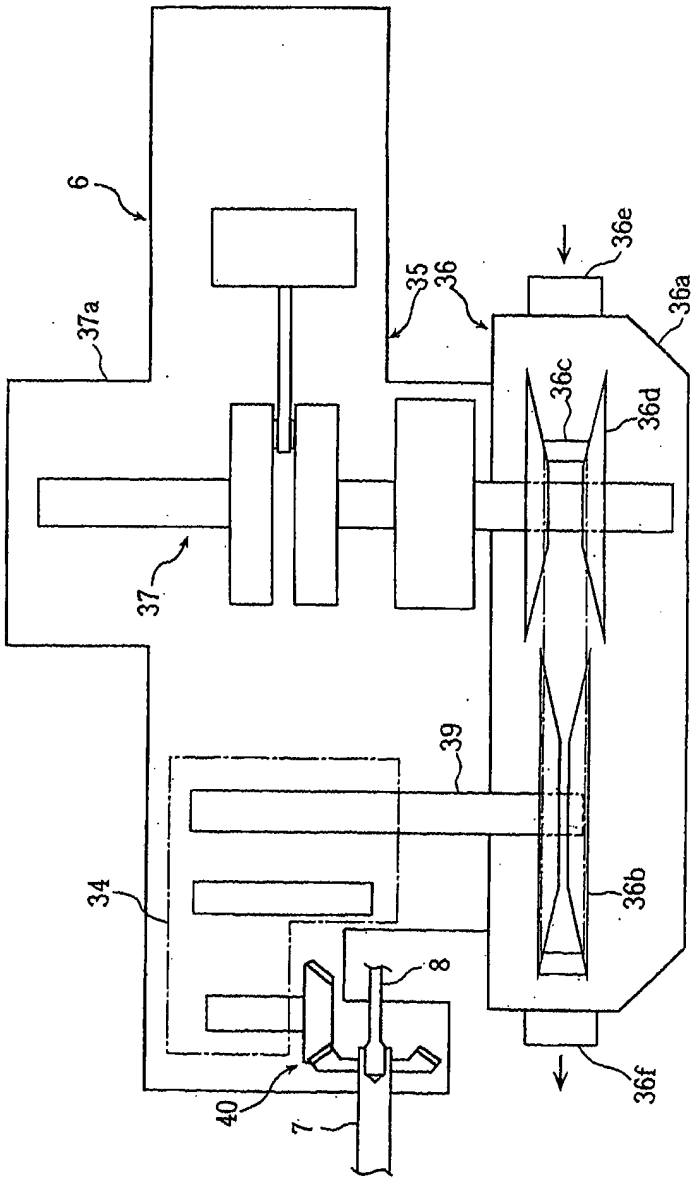

FIG. 4

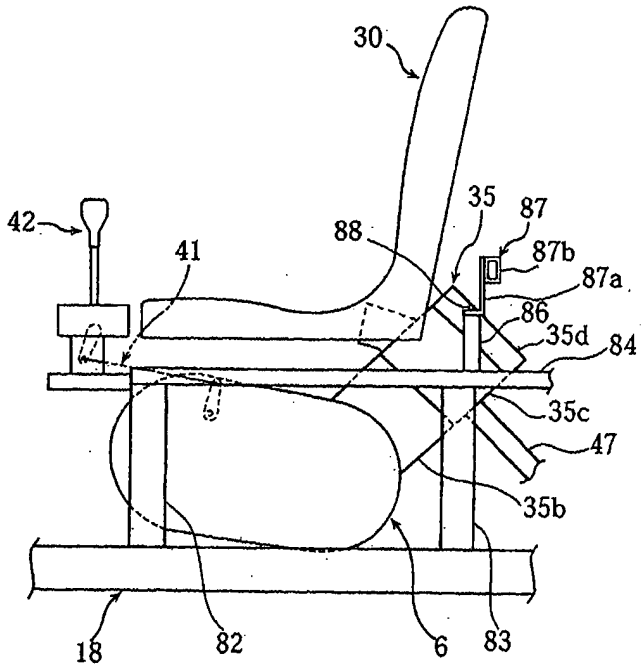

FIG. 5

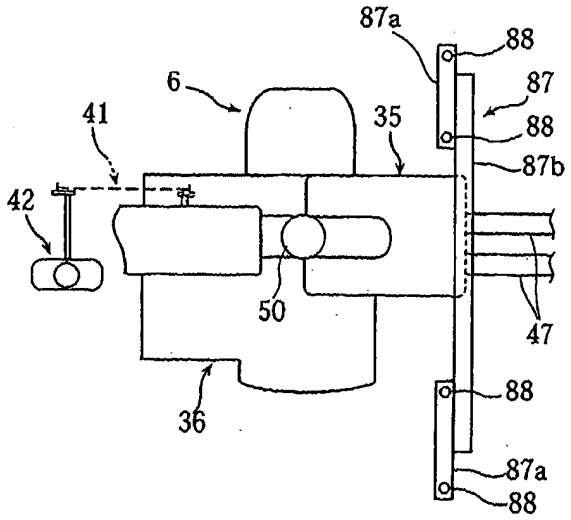

FIG. 6

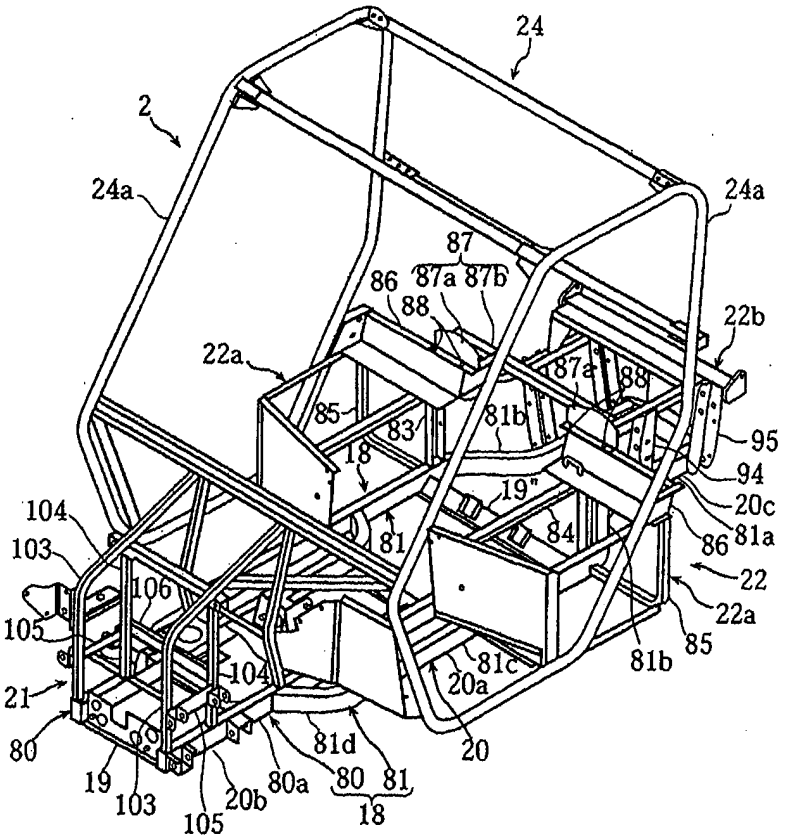

FIG. 7

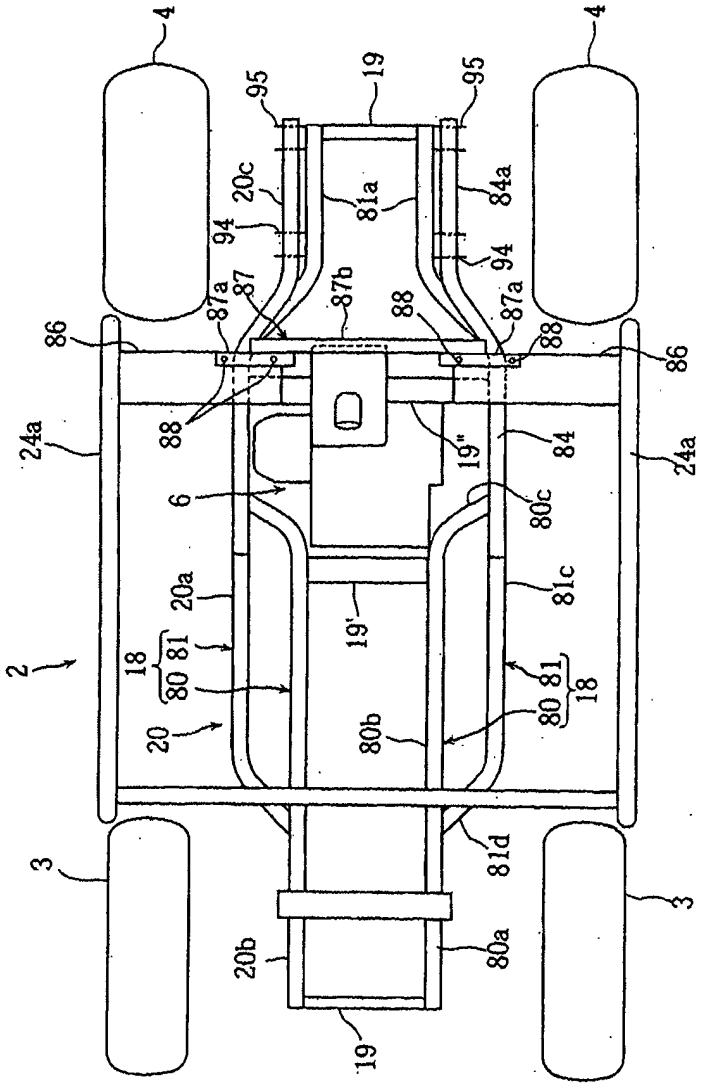

FIG. 8

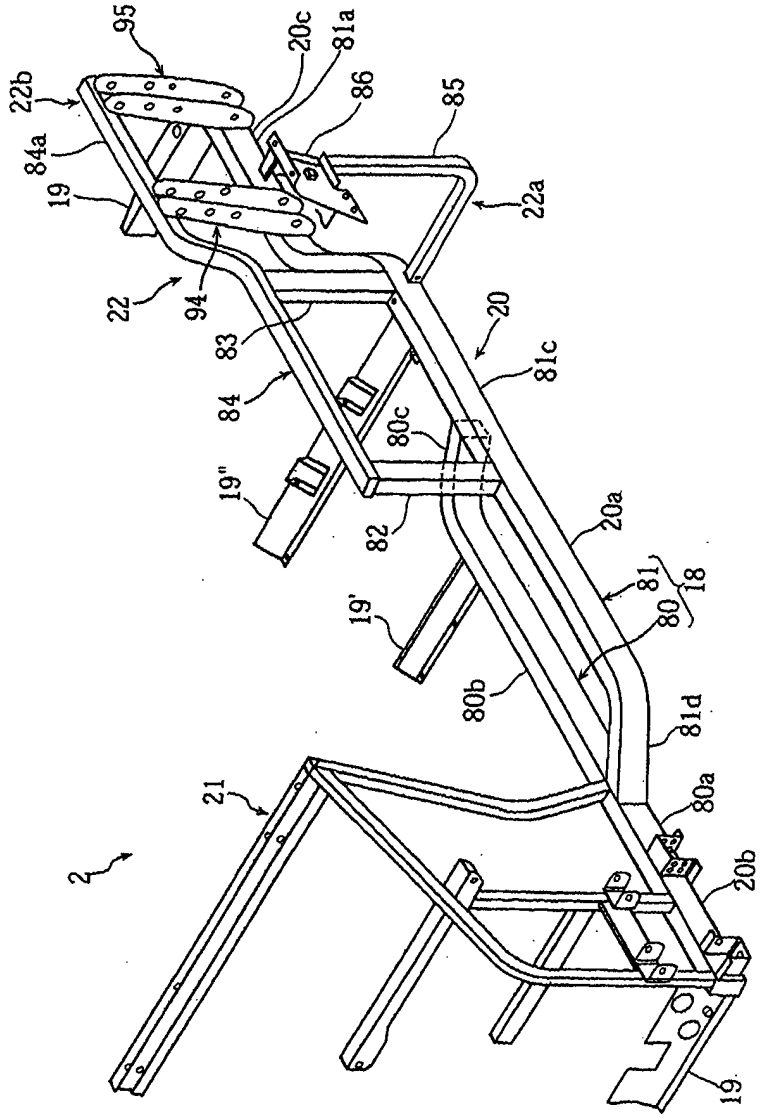

FIG. 9

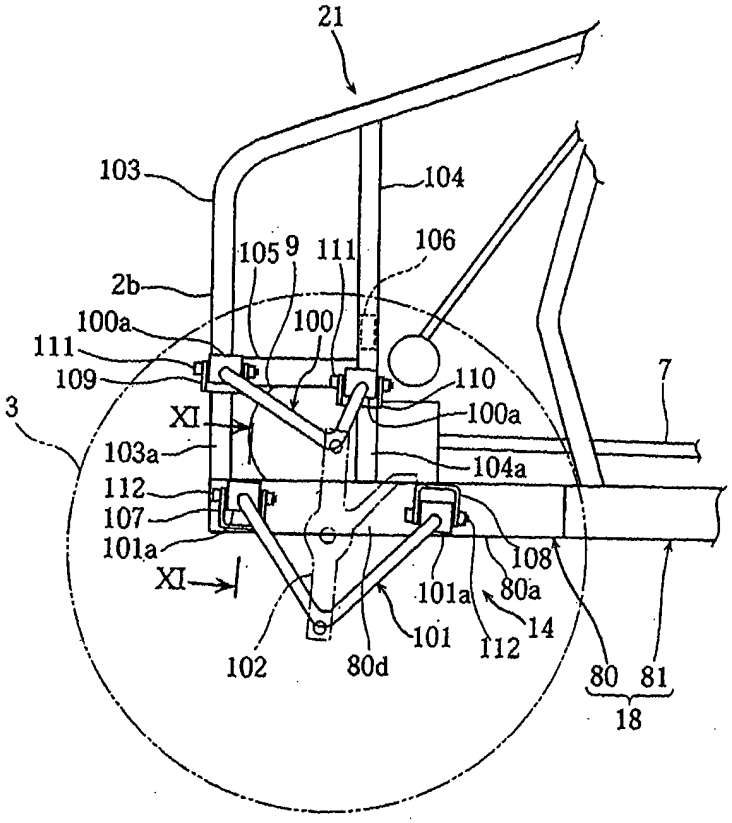

FIG. 10

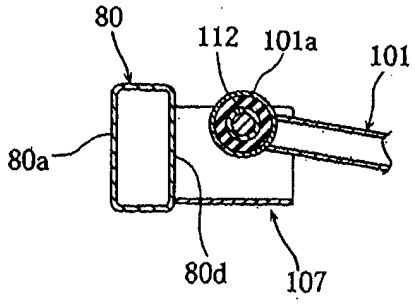

FIG. 11

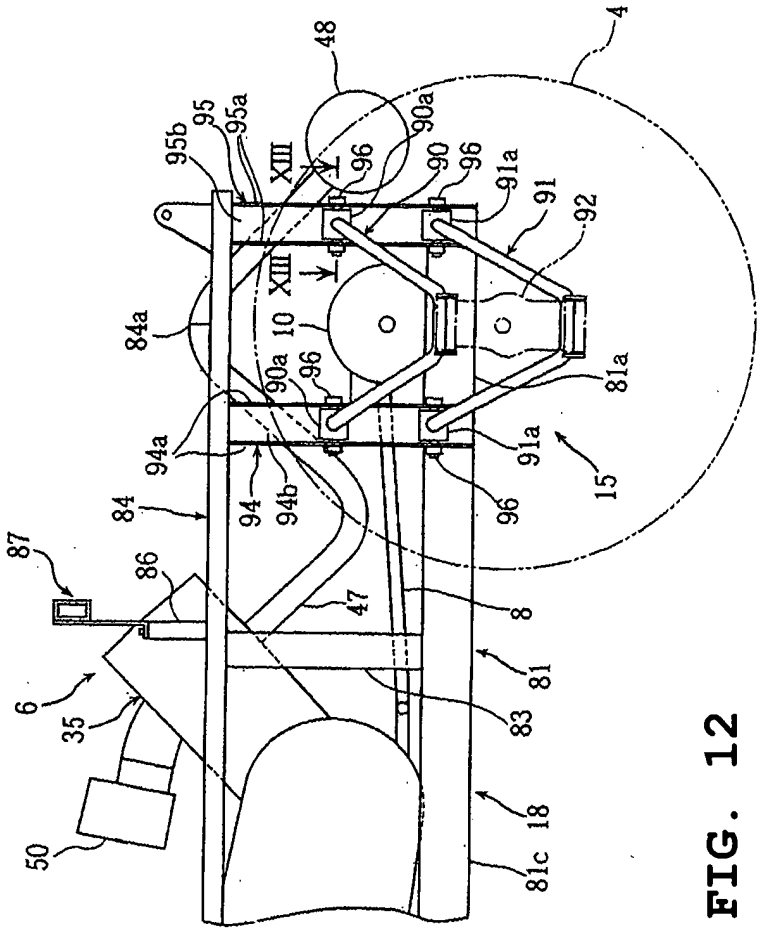

FIG. 12

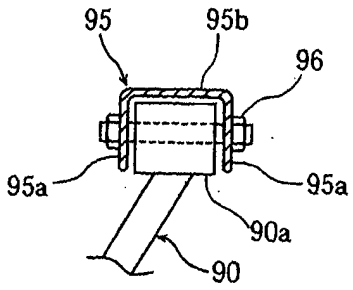

FIG. 13

[Document name] Abstract

[Abstract]

[Object] To provide a body frame for an all-terrain vehicle that allows improving the serviceability during the maintenance work, while assuring the supporting rigidity for an engine.

[Solution] An engine frame member 87 covering the upper side of an engine unit 6 is made detachable when constructing a body frame for an all-terrain vehicle.

[Selected Drawing] Fig. 5